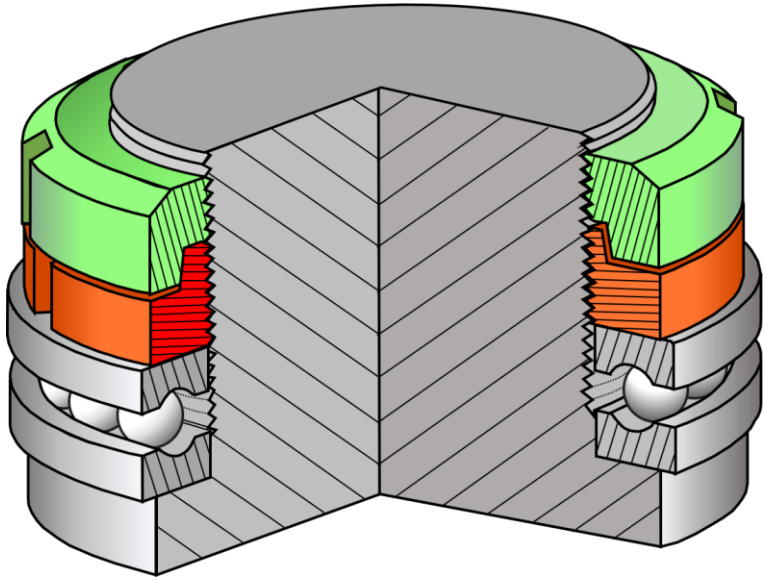
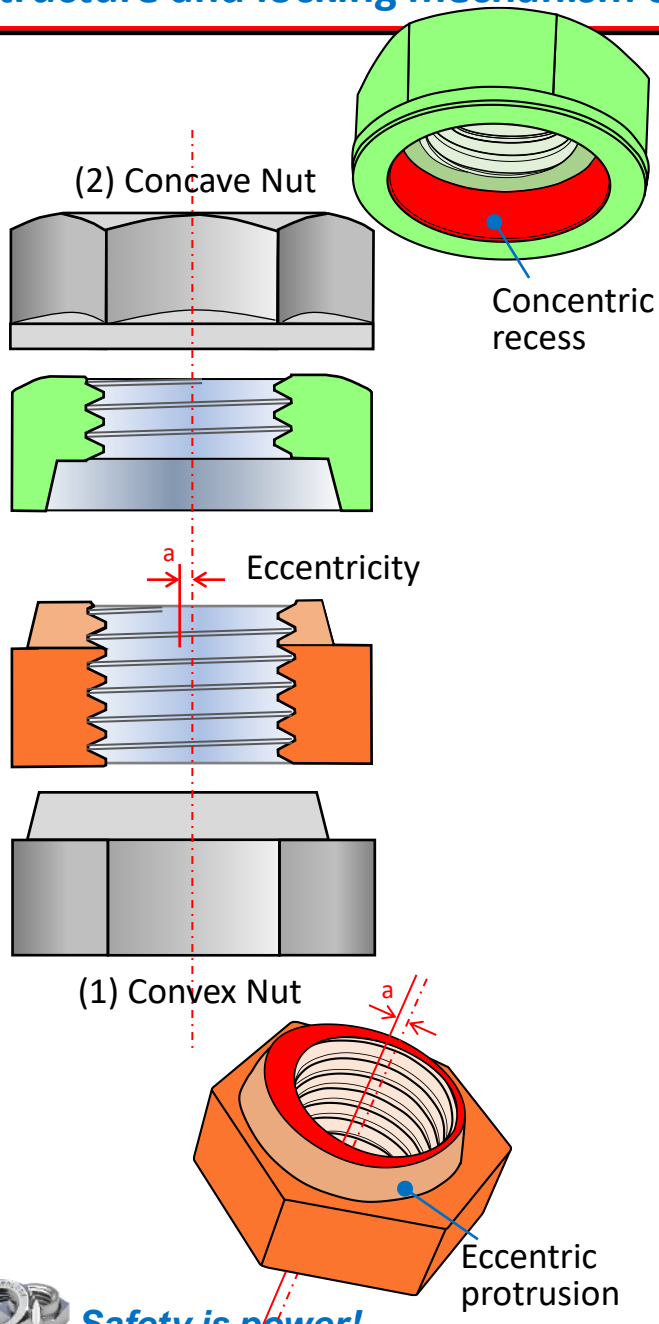
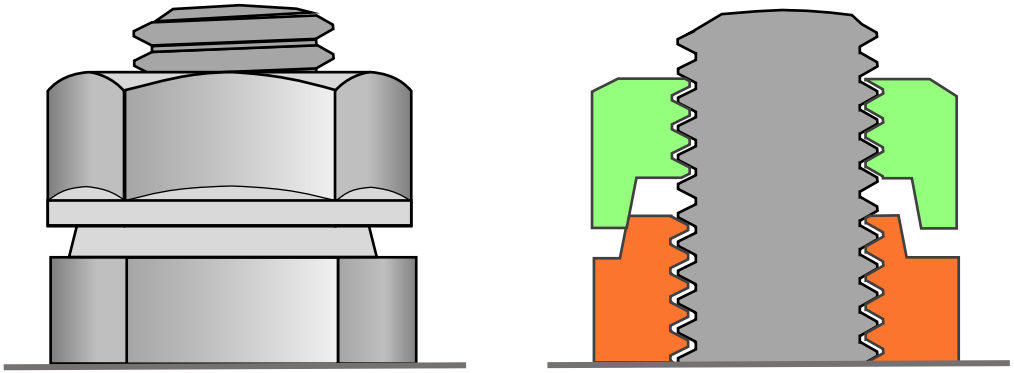


HARDLOCK® Solution

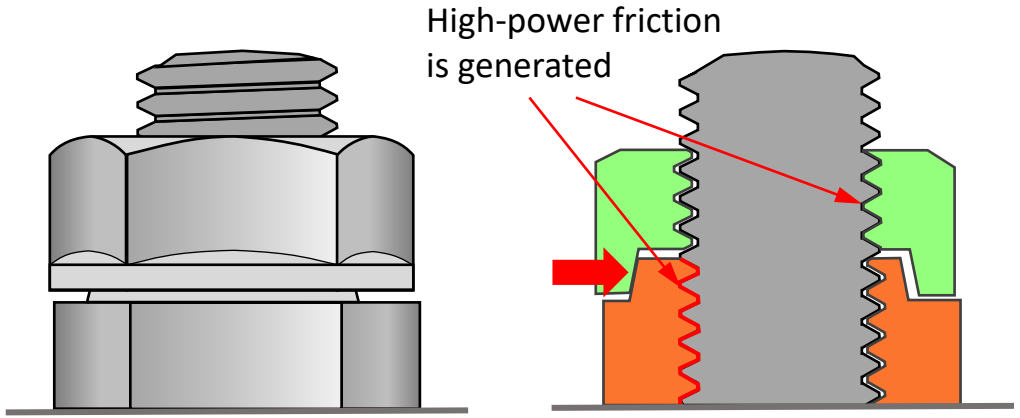
Injection Molding Machines Applications

Structure and locking mechanism of HARDLOCK Nut (HLN)





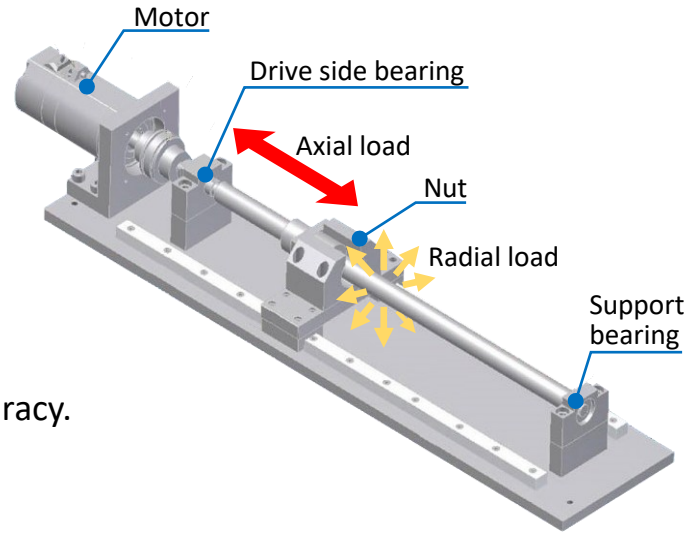
The first nut **(1) Convex Nut** (clamping nut) has an **eccentric conical protrusion** on the upper surface. The Convex Nut that has the same strength class as a regular hexagon nut is to be tightened to the appropriate torque for the application.
The Concave Nut is screwed down manually by hand until it no longer turns.



The second nut **(2) Concave Nut** (locking nut) is designed with a concentric conical recess that contacts the protrusion of Convex Nut to generate a strong perpendicular load with resultant elimination of the play (gap) between the Convex Nut and bolt.

HARDLOCK Bearing Nut (**HLB**) used for Ball Screws of Injection Molding Machines

HARDLOCK Bearing Nut (HLB) has the same locking mechanism as **HARDLOCK Nut**

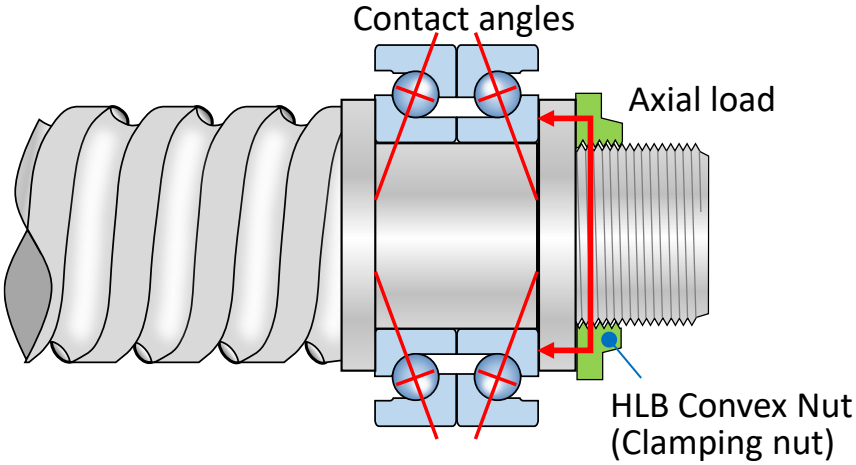


More and more injection molding machines utilize ball screws with accurate servo motors to ensure the quality and shorten the manufacturing cycle.

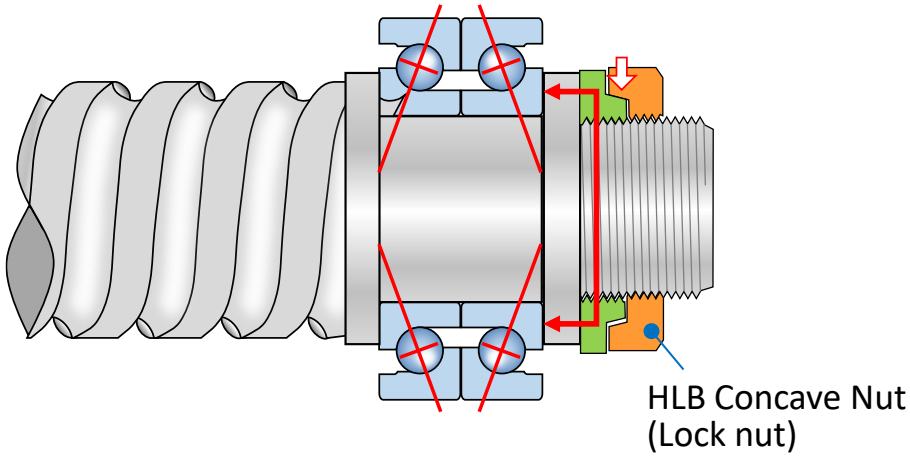
The ball screws for the injection molding machine are required to bear **high load and rotary movement starting/stopping at high speed within a short distance**, which places high demands on **bearings** and **lock nuts** as well.

Applications such as injection molding machines, robots and machine tool spindles require precision rotary motion with a higher degree of stiffness and positional accuracy. To achieve this, a sustained load must be applied to the drive side bearings during assembly to remove excess play - that is called **preload**.

① Exact preload can be achieved by torque control tightening on the HLB Convex Nut



② HLB Concave Nut will lock the Convex Nut regardless of the amount of preload



HARDLOCK Bearing Nut can be tightened to exact torque required to generate correct **preload** and at the same time stay still to support the bearings that carry **high axial load represented by thrust and reaction force**.

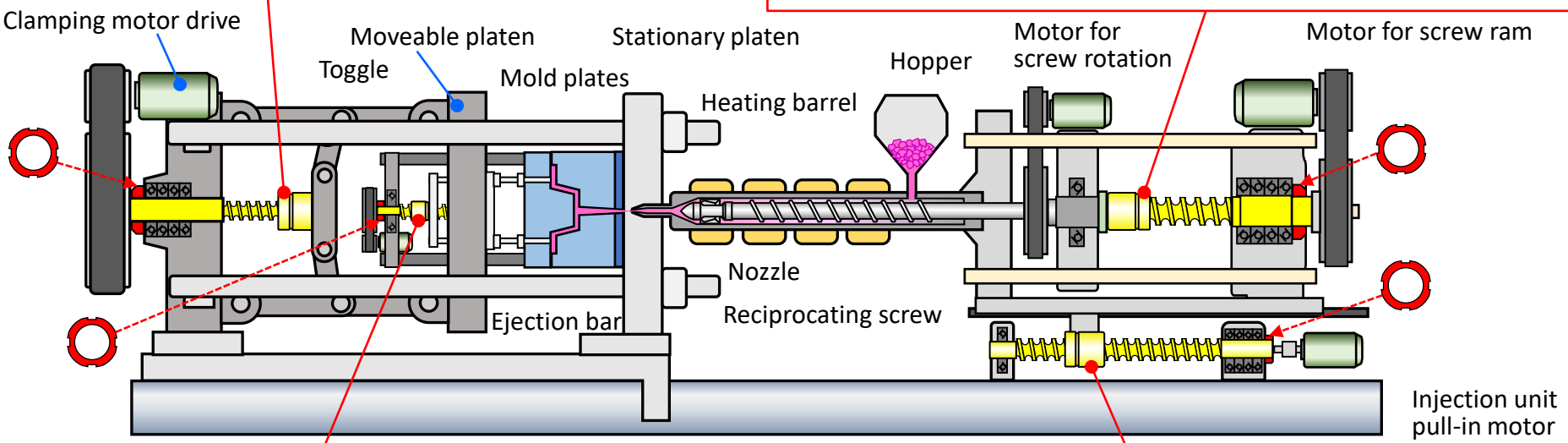
Ball Screws in the Injection Molding Machine

HARDLOCK Bearing Nuts (HLB) have great potential for the use with Ball Screws especially for mold clamping and screw ram, where high load capability is required.

HARDLOCK Bearing Nut can be considered for use.

Ball screw for mold clamping
The molten plastic is forced under high pressure injected into the mold cavity, the clamping force applied to molds must oppose the separating force caused by the injection. It varies from 50kN to over 15,000kN depending on the size of products and required accuracy.

Ball screw for screw ram
The molten plastic is driven by a reciprocating screw into the mold. Then the screw is forced forward to apply pressure to make sure that all of cavities and spaces have been filled and keep appropriate pressure for the duration of a cooling time. The cavity needs to be filled quickly before the gate becomes blocked by solidified plastic.
The ball screw shall carry axial loads and high speed and the injection pressure can range from 35-140 MPa.



Ball screw for ejection bar
The plastic material is removed from the mold with an ejection system using ejector pins. The mold can be shut again after ejection and another shot can be injected for the process to begin again.
This requires less power than clamping and injection process.

Ball screw for injection unit pull-in
This process is required only for the start of repeated molding cycles. The actuator moves the injection unit forward to have the nozzle of the injection cylinder contact the sprue bushing of the molding die.
This is slow speed process and high power is not required.

Diagram of an electric injection molding machine (Some mechanical details are simplified)

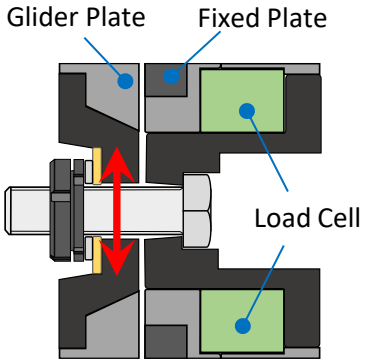
Comparison between Toothed Lock Nut and HLB (2)

3. Vibration Test using Junker Test Bench J900

(1) Product under test

Size: M20xP1.0
Material: JIS S45C
Finish: Manganese Phosphate (HLB, Ordinary Lock Nut)
Zinc Trivalent Chromate (Other Self-Lock Lock Nut)

Vibrationmaster J900 allows the testing and verification of fasteners in accordance with DIN 25201-4 and ISO 16130 for the self-loosening behaviour under dynamic load



Test fixture

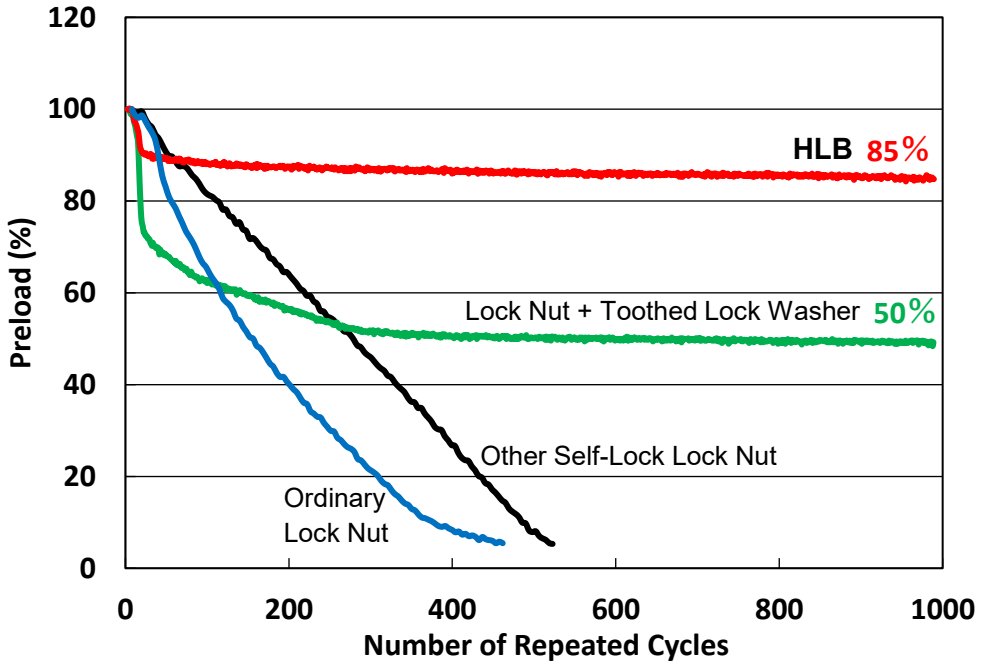
The specimen is exposed to transverse motion creating cyclic vibration

(2) Test Conditions

Initial Clamp Force: 17.2kN (10-20% of yield point for 8.8 bolt)
(Lower clamp force was set on the assumption of the case where much preload can not be applied)
Transverse displacement: +/-1.25mm
Test frequency: 2Hz (to prevent galling)
Test cycles: 1000 cycles
Lubrication: All the threads and engagement part of HLB were lubricated

(3) Test Results

Toothed Lock washers can surely prevent rotational loosening against vibration, but the reduction of preload to some extent is inevitable.



4. Normal-reverse Rotation Endurance Test on Lock Nut

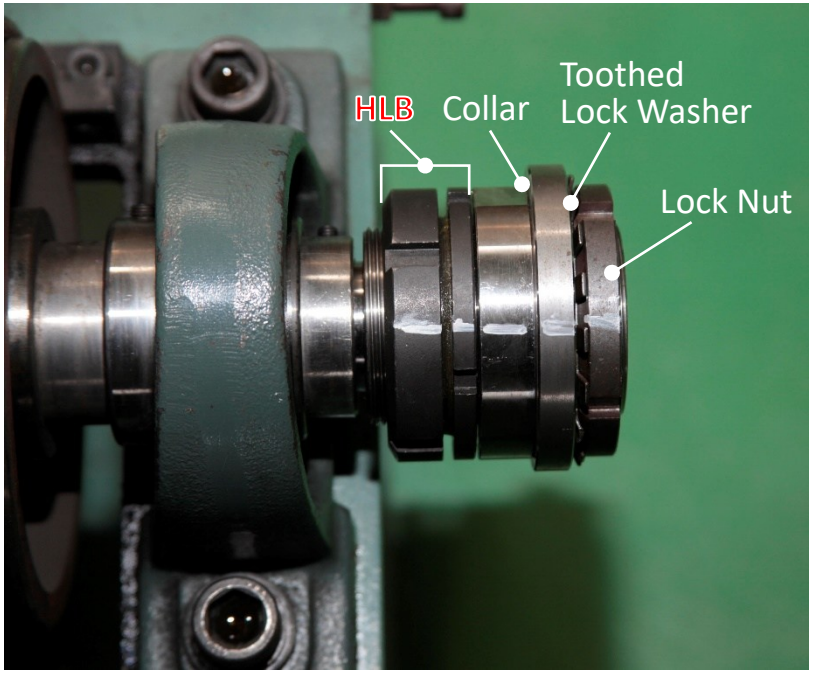
(1) Test Conditions

Specimen: M55xP2.0 (JIS S45C)
Rotating Speed: 2,300rpm
One Cycle: 10 seconds
(Normal ROT-Stop-Reverse ROT-Stop)
Stop time: 0.30 sec (Normal rotation)
0.27 sec (Reverse rotation)
Fictitious Force at the time of stopping:
0.29Nm (Normal rotation)
0.32Nm (Reverse rotation)

(2) Test Results

Specimen	Specimen No.	Test Results
Lock Nut + Toothed Lock Washer	1	Loosening occurred in about 150,000 cycles
	2	Loosening occurred in about 120,000 cycles
HLB	1	**No loosening occurred in 1mil cycles**
	2	**No loosening occurred in 1mil cycles**

Testing machine



Specimens set on the test shaft